PATENT ABSTRACTS OF JAPAN

(11)Publication number : 04-269153
(43)Date of publication of application : 25.09.1992

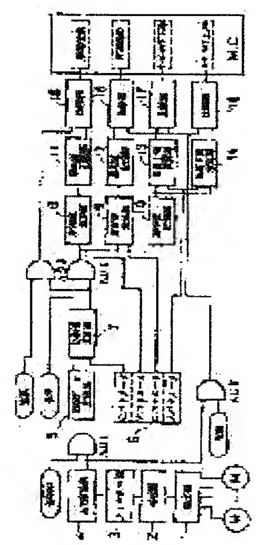
(51)Int.Cl. B23Q 17/09

(21)Application number : 03-028727
(22)Date of filing : 22.02.1991

(71)Applicant : HITACHI SEIKI CO LTD
(72)Inventor : TERAJIMA ATSUSHI

(54) MONITORING METHOD FOR CUTTING LOAD BY DATA EXTRACT MEAN METHOD

(57)Abstract:
PURPOSE: To obtain a cutting load monitoring device of a high reliability, a good responsiveness as well and easy to discriminate an operator and to change data in cutting.
CONSTITUTION: A teaching cut is executed prior to an actual work in order to obtain a monitoring reference value. At that time, the cutting load detection data of each process detecting from a spindle and feed shaft are stored. At the time when the cutting of each process is finished, the load value adapted to the actual cutting of the work tool thereof is operated, the value thereof is stored as the cutting load reference value of the tool. A cutting abnormality decision value and wear decision value are stored with their operation from this reference value and also the graphic display of a cutting load state and cutting load reference value, the cutting abnormality decision value and wear decision value are displayed in a chart.



LEGAL STATUS
[Date of request for examination]
[Date of sending the examiner's decision of rejection]
[Kind of final disposal of application other than the examiner's decision of rejection or application converted registration]
[Date of final disposal for application]
[Patent number]
[Date of registration]
[Number of appeal against examiner's decision of rejection]
[Date of requesting appeal against examiner's decision of rejection]
[Date of extinction of right]

CLAIMS

(57) [Claim(s)]
[Claim 1] In a machine tool, the cutting load under instruction cutting is detected from the drive system of a main shaft or a feed shaft. Memorize the detected instruction cutting load data in the storage section, and this memorized instruction cutting load data is classified into descending of a load value after cutting termination. In order to remove the maximum load side unstable data based on the effect of a noise or disturbance from this classified instruction cutting load data Extract the 1st instruction effective cutting load data which deleted the data of the 1st high order predetermined range which can be set up for every classification of a tool at least, and from this 1st extracted instruction effective cutting load data, while being high order data by the side of maximum load close attendants The data of the 2nd high order predetermined range which can be set up for every classification of said tool at least are extracted as 2nd instruction effective cutting load data. Carry out the averaging operator of this 2nd extracted instruction effective cutting load data, and a cutting load value is calculated. This cutting load value is made into the reference value of a cutting load, the multiplication of the predetermined multiplier for cutting load decision is carried out to this cutting load reference value, and the abnormality decision value in cutting is calculated. This abnormality decision value in cutting, The cutting load monitor approach by the data extraction method of averaging characterized by comparing the cutting load data detected from the drive system of the main shaft under real cutting, or a feed shaft, and for this cutting load data judging whether they are abnormalities, and outputting the signal of the abnormalities in cutting in the case of abnormalities.
[Claim 2] In a machine tool, the cutting load under instruction cutting is detected from the drive system of a main shaft or a feed shaft. Memorize the detected instruction cutting load data in the storage section, and this memorized instruction cutting load data is classified into descending of a load value after cutting termination. In order to remove the maximum load side unstable data based on the effect of a noise or disturbance from this classified instruction cutting load data Extract the 1st instruction effective cutting load data which deleted the data of the 1st high order predetermined range which can be set up for every classification of a tool at least, and from this 1st extracted instruction effective cutting load data, while being high order data by the side of maximum load close attendants The data of the 2nd high order predetermined range which can be set up for every classification of said tool at least are extracted as 2nd instruction effective cutting load data. Carry out the averaging operator of this 2nd extracted instruction effective cutting load data, and a cutting load value is calculated. Make this cutting load value into the reference value of a cutting load, carry out the multiplication of the predetermined multiplier for wear decision to this cutting load reference value, and a wear decision value is calculated. Detect the cutting load under real cutting from the drive system of a main shaft or a feed shaft, and the detected real cutting load data is memorized in the storage section. In order to classify this memorized real cutting load data into descending of a load value after real cutting termination and to remove the maximum load side unstable data based on the effect of a noise or disturbance from this classified real cutting load data Extract the 1st real effective cutting load data which deleted the data of the 1st high order predetermined range

which can be set up for every classification of a tool at least, and from this 1st extracted real effective cutting load data, while being high order data by the side of maximum load close attendants The data of the 2nd high order predetermined range which can be set up for every classification of said tool at least are extracted as 2nd real effective cutting load data. Carry out the averaging operator of this 2nd extracted real effective cutting load data, and a real cutting load value is calculated. The cutting load monitor approach by the data extraction method of averaging characterized by comparing this real cutting load value with said wear decision value, and for this real cutting load value judging whether they are abnormalities, and outputting the signal of tool wear in the case of abnormalities.

[Claim 3] In claim 1 or claim 2 said 1st instruction effective cutting load data from said classified instruction cutting load data Or the method of asking for said 1st real effective cutting load data from said classified real cutting load data In order to classify said memorized instruction cutting load data or said real cutting load data into descending of a load value and to remove the effect by change of the amount of cutting from said classified instruction cutting load data or said real cutting load data after cutting termination, Read the cutting load value of the data of the high order predetermined number of the number of cutting load datas, and the data of the 3rd high order predetermined range of this cutting load value are extracted as the 3rd instruction effective cutting load data or 3rd real effective cutting load data. In order to remove the maximum load side unstable data based on the effect of a noise or disturbance from said this 3rd extracted instruction effective cutting load data or the 3rd real effective cutting load data The cutting load monitor approach by the data extraction method of averaging which considers as the approach of extracting and asking for the 1st instruction effective cutting load data or the 1st real effective cutting load data which deleted the data of the 1st high order predetermined range which can be set up for every classification of a tool, and is characterized by the effect by change of the amount of cutting being removable.

[Translation done.]

DETAILED DESCRIPTION

[Detailed Description of the Invention]
[0001]
[Industrial Application] This invention relates to the approach of supervising the cutting condition at the time of processing of a machine tool.
[0002]
[Conventional example] As an approach of supervising the cutting condition of a machine tool and performing efficient operation, there is the approach of supervising the cutting load of a main shaft motor or a feed shaft servo motor.
[0003] A current value is detected as a cutting load under cutting from the drive motor of a main shaft or a feed shaft. When detecting the abnormalities in cutting, once, perform instruction cutting and from the cutting load detection data (cutting load data) except the high frequency noise component at that time (a) Or it set up the maximum of a cutting load data as a reference value, the continuation N time average of (b) cutting load data was computed, the maximum of that average was calculated as a reference value, and it was supervising by comparing the limit set point and real cutting data based on this reference value.
[0004] Moreover, as for tool wear, wear of a tool is detected as a dc-component rise of a cutting load and a rise of a load effect. Therefore, or it compares and detects change of the dc component which filtered (c) detection data, (d) detection data are compared, a time amount element is put into relation condition, and detection processing is performed by the approach of detecting the rise of a dc component.
[0005]
[Problem(s) to be Solved by the Invention] However, since the approach of making maximum of a cutting load data a reference value or the approach of making a reference value maximum of the continuation N time average value of a cutting load data is carried out based on the maximum of a cutting load data, the trouble shown below exists.
[0006] That is, fluctuation may produce a cutting load data with the transfer loss of a drive, or the response characteristic of a drive system also in the condition of not cutting. Fluctuation also becomes large, so that it is heavy machining especially. Moreover, by the milling cutter or end mill cutting, even if it cuts without changing cutting conditions, since it becomes intermittence cutting, a cutting load data will be changed. Especially, as for a drill etc., a chip changes a slag cutting load data. And in a continuation N time average, since the fluctuation cycle of a cutting load data changes by various cutting conditions etc., the effective count N of equalization cannot be decided. Moreover, if the count N of equalization is made [many], data will be stabilized, but while the response to a cutting load data becomes slow, change of a cutting load data will become low. Furthermore, since the data reliability of a reference value becomes low as for the approach of a difference being between an average cutting load value and maximum, and making large maximum of fluctuation a reference value as data, naturally monitor sensibility also worsens. Moreover, when enlarging the count N of equalization, although stabilized, since a response became slow, data had produced the trouble that there was a possibility that change of a rise of sudden cutting load values, such as tool breakage, etc. may be undetectable.

[0007] thus, the criterion value which supervises in the monitor approach of a cutting load -- taking -- the direction and precision -- ** -- it is set to one of the important technical problems.
[0008] Moreover, the trouble shown below exists in the above mentioned wear detection processing.
[0009] That is, since the filtered dc-component data compare, a data-processing system other than the processor of the monitor of the above mentioned cutting load is required, and a data-processing system becomes a duplex and becomes cost quantity. Two kinds of data setup for the abnormalities in cutting and wear is needed, and for an operator, it is complicated and unclear. Since it filters, cutting data become low and detection precision falls. Moreover, the direction of the worn-out tool had also produced the trouble that the data range of fluctuation became large and the effect of filtering became large.
[0010] It is this invention being originated in view of this technical problem, and memorizing the cutting load data of instruction cutting. By having judged the loaded condition of the whole cutting from that memorized cutting load data, having calculated the cutting load value adapted to real cutting, and having made this value into the reference value of a cutting load monitor at the time of cutting termination It is intelligibly reliable and, moreover, responsibility is also aimed at offering the monitor approach of a cutting load that a good cutting load monitor can be performed.
[0011]
[Means for Solving the Problem] In order to solve said technical problem, the 1st invention is set to a machine tool. The cutting load under instruction cutting Detect from the drive system of a main shaft or a feed shaft, and the detected instruction cutting load data is memorized in the storage section. In order to classify this memorized instruction cutting load data into descending of a load value after cutting termination and to remove the maximum load side unstable data based on the effect of a noise or disturbance from this classified instruction cutting load data Extract the 1st instruction effective cutting load data which deleted the data of the 1st high order predetermined range which can be set up for every classification of a tool at least, and from this 1st extracted instruction effective cutting load data, while being high order data by the side of maximum load close attendants The data of the 2nd high order predetermined range which can be set up for every classification of said tool at least are extracted as 2nd instruction effective cutting load data. Carry out the averaging operator of this 2nd extracted instruction effective cutting load data, and a cutting load value is calculated. This cutting load value is made into the reference value of a cutting load, the multiplication of the predetermined multiplier for cutting load decision is carried out to this cutting load reference value, and the abnormality decision value in cutting is calculated. This abnormality decision value in cutting, The cutting load data detected from the drive system of the main shaft under real cutting or a feed shaft is compared, this cutting load data judges whether they are abnormalities, and it is characterized by outputting the signal of the abnormalities in cutting in the case of abnormalities.
[0012] The 2nd invention is set to a machine tool. Moreover, the cutting load under instruction cutting Detect from the drive system of a main shaft or a feed shaft, and the detected instruction cutting load data is memorized in the storage section. In order to classify this memorized instruction cutting load data into descending of a load value after cutting termination and to remove the maximum load side unstable data based on the effect of a noise or disturbance from this classified instruction cutting load data Extract the 1st instruction effective cutting load data which deleted the data of the 1st high order predetermined range which can be set up for every classification of a tool at least, and from this 1st extracted instruction effective cutting load data, while being high order data by the side of maximum load close attendants The data of the 2nd high order predetermined range which can be set up for every classification of said tool at least are extracted as 2nd instruction effective cutting load data. Carry out the averaging operator of this 2nd extracted instruction effective cutting load data, and a cutting load value is calculated. Make this cutting load value into the reference value of a cutting load, carry out the multiplication of the predetermined multiplier for wear decision to this cutting load reference value, and a wear decision value is calculated. Detect the cutting load under real

cutting from the drive system of a main shaft or a feed shaft, and the detected real cutting load data is memorized in the storage section. In order to classify this memorized real cutting load data into descending of a load value after real cutting termination and to remove the maximum load side unstable data based on the effect of a noise or disturbance from this classified real cutting load data Extract the 1st real effective cutting load data which deleted the data of the 1st high order predetermined range which can be set up for every classification of a tool at least, and from this 1st extracted real effective cutting load data, while being high order data by the side of maximum load close attendants The data of the 2nd high order predetermined range which can be set up for every classification of said tool at least are extracted as 2nd real effective cutting load data. The averaging operator of this 2nd extracted real effective cutting load data is carried out, and a real cutting load value is calculated, this real cutting load value is compared with said wear decision value, this real cutting load value judges whether they are abnormalities, and it is characterized by outputting the signal of tool wear in the case of abnormalities.

[0013] The 3rd invention is set to the 1st invention or invention of the 2nd. Furthermore, said 1st instruction effective cutting load data from said classified instruction cutting load data Or the method of asking for said 1st real effective cutting load data from said classified real cutting load data In order to classify said memorized instruction cutting load data or said real cutting load data into descending of a load value and to remove the effect by change of the amount of cutting from said classified instruction cutting load data or said real cutting load data after cutting termination, Read the cutting load value of the data of the high order predetermined number of the number of cutting load datas, and the data of the 3rd high order predetermined range of this cutting load value are extracted as the 3rd instruction effective cutting load data or 3rd real effective cutting load data. In order to remove the maximum load side unstable data based on the effect of a noise or disturbance from said this 3rd extracted instruction effective cutting load data or the 3rd real effective cutting load data It considers as the approach of extracting and asking for the 1st instruction effective cutting load data or the 1st real effective cutting load data which deleted the data of the 1st high order predetermined range which can be set up for every classification of a tool, and is characterized by the effect by change of the amount of cutting being removable.

[0014]

[Function] In the supervisory equipment of the cutting load possessing the display which displays the loaded condition at the time of cutting, in order to acquire the cutting load reference value to supervise, instruction cutting is performed in advance of actual processing. When the cutting load data of each process detected from the drive system of a main shaft or a feed shaft is then memorized and cutting of each process finishes, the instruction cutting load value adapted to real cutting of the processing tool is calculated, and the value is memorized as a reference value of the cutting load of a tool. While calculating and memorizing the abnormality decision value in cutting, and a wear decision value from this cutting load reference value, since the reference value, the abnormality decision value in cutting, and wear decision value of a cutting load by the graphical display and the operation of cutting loaded condition at the time of cutting are indicated by drawing, in discernment, it can do easily and data modification can also carry [operator] out easily.

[0015] Moreover, at this time, the monitor of the abnormalities in cutting can be supervised by the abnormality decision value in cutting and real time comparing a real cutting load data, and tool wear can calculate a real cutting load value each time at the time of cutting termination, and can be supervised as compared with a wear decision value. Furthermore, adaptive control which changes a cutting feed rate timely is also performed so that a real cutting load may go into cutting load within the limits drawn from a cutting load reference value.

[0016]

[Example] Hereafter, one example of this invention is explained in detail based on a drawing.

[0017] Drawing 1 is the block diagram of the cutting load supervisory equipment which carries out this invention.

[0018] M-C shown in drawing 1 is the control device (an NC unit, programmable controller) of a

machine tool, and has the wear detection processing means, the malfunction detection processing means, the delivery exaggerated light downward means, the delivery exaggerated light rise means, etc.
[0019] 1 is a detecting element and detects a motor load (current value) as a cutting load from a main shaft drive motor or a feed shaft drive motor. The amplifier which amplifies the current value which detected 2 by the detecting element 1, the filter section from which 3 removes electrical noise, and 4 are the A/D-conversion sections which change an analog signal into a digital signal. In addition, this digital data performs concrete control decision processing.
[0020] AD1 is an AND gate, and if the signal under cutting is inputted, it will output data to the cutting data storage section 5. The cutting data storage section 5 memorizes the cutting load data under cutting. 6 is the various parameter sections which have memorized the numeric value used by each operation part. 7 is C parameter 6C of a cutting load data and the various parameter sections 6 which was cutting value operation part, and processing was started and was memorized in the cutting data storage section 5 when cutting was completed. With the parameter for an operation of the processing tool set up, the cutting load value at that time is calculated, and the reference-value storage section 10 memorizes the calculated cutting load value as a reference value. 8 is wear value operation part and is W parameter 6W of said cutting load reference value and parameter section 6 at the wear value operation part 8. It calculates with the multiplier for wear decision set up, and the result is memorized in the wear value storage section 11 as a wear decision value. 9 is outlying-observation operation part and is O parameter 6O of said cutting load reference value and parameter section 6 at the outlying-observation operation part 9. It calculates with the multiplier for cutting load decision set up, and the result is memorized in the cutting outlying-observation storage section 12 as an abnormality decision value in cutting. W parameter 6W and O parameter 6O The multiplier memorized can be set up for every tool and every tool classification.
[0021] AD2 is an AND gate, and if the instruction signal that a cutting load value is calculated after cutting termination in the cutting value operation part 7 and instruction cutting is carried out is inputted, it will output a Konomi cutting load value to the wear value operation part 8, the outlying-observation operation part 9, and the reference-value storage section 10.
[0022] AD3 is an AND gate, and while performing not instruction cutting but real cutting and supervising the cutting load (i.e., when the supervisory signal is inputted), it outputs the real cutting load data under real cutting to a comparator 16, a comparator 17, and a comparator 18 on real time. Moreover, the real cutting load value calculated by the cutting value operation part 7 after real cutting termination is outputted to a comparator 15.
[0023] In a comparator 15, when the wear decision value memorized by the wear value storage section 11 is compared with the real cutting load value when real-cutting this time and it becomes a wear decision value < real cutting load value, a tool wear detecting signal is outputted to a control unit MC.
[0024] In a comparator 16, when the abnormality decision value in cutting memorized by the outlying-observation storage section 12 is compared with the real cutting load data of the real time under real cutting and it becomes an abnormality decision value in cutting < real cutting load data, a tool malfunction detection signal is outputted to control unit M-C.
[0025] 13 is the cutting load reference value and A parameter 6A which are cutting load upper limit operation part, and were memorized by the reference-value storage section 10. The upper limit of the cutting load permitted by the tool currently cut with the set-up multiplier is calculated, and the result is outputted to a comparator 17.
[0026] 14 is cutting load minimum operation part, calculates the lower limit of the cutting load similarly permitted by the tool currently cut, and outputs the result to a comparator 18. This A parameter 6A It is possible to set it as arbitration for every tool, for example, a multiplier is [0027]. Cutting load upper limit = 120%x cutting load reference value, [0028] Cutting load lower limit = 80%x cutting load reference value [0029] Then, the multiplier of "120" and "80" is set up.
[0030] In comparators 17 and 18, the cutting load upper limit and cutting load lower limit which were calculated respectively are compared with the real cutting load data of the real time under real cutting, and when a real cutting load data is more than a cutting load upper limit, or when it

is below a cutting load lower limit, an override downward signal or an override rise signal is outputted to control-device M-C.
[0031] Next, the data-processing approach of the cutting load value performed in the cutting value operation part 7 is explained.
[0032] The effect according to outbreak data from the cutting load data memorized by said cutting data storage section 5, In order to remove the effect by change of the amount of cutting shown in the example of a cutting pattern of drawing 4 of [for maximum load side unstable data] Classify all data into descending of a load value, and from this classified instruction cutting load data, while being high order data of descending of the load value by the side of maximum load close attendants The cutting load data of 1st predetermined % which makes the cutting load-data total decided by every classification of a cutting tool 100% of a percentage within the limits is extracted. That is, an inner 10% number of high orders of cutting load values which made the number the classified instruction cutting load-data total 100% are read, and M% or more (3rd high order predetermined range) of cutting load data (3rd effective cutting load data) of the cutting load value is extracted. In addition, although usually considered as 60% M%, it constitutes so that it can be set as arbitration for every classification of a tool, and every tool. In addition, 1st predetermined % is [10xM/100]%.
[0033] Subsequently, assignment of the operation exclusion range is explained. The data by the side of the maximum load are influenced of a noise, disturbance, etc., and turn into unstable data. Then, in order to lose this effect, said cutting load data of the range (1st high order predetermined range) of the 2nd predetermined % by the side of the maximum load decided for every classification of a cutting tool of the inside which made the number the cutting load-data total extracted in said 1st predetermined % 100% (for example, S % number) is removed. In addition, although usually considered as 5% S%, it constitutes so that it can be set as arbitration for every classification of a tool, and every tool.
[0034] In order to acquire the fixed load reference value which is not confused by the load effect from the cutting load data after this exclusion (1st effective cutting load data), the effective cutting load data (2nd effective cutting load data) at the time of instruction cutting which is the cutting load data of the range (2nd high order predetermined range) of 3rd predetermined % by the side of the maximum load decided for every classification of a cutting tool (for example, P % number), or real cutting is extracted. That is, a fixed load reference value can be acquired, without being confused by the load effect if any cutting pays its attention to data with a larger cutting load data since cutting exceeding cutting conditions is not performed although a cutting load data is changed. Then, this computing range is specified at P %. In addition, although usually considered as 10% P%, it constitutes so that it can be set as arbitration for every classification of a tool, and every tool.
[0035] Usually, an effective data is chosen from the memorized cutting load data, and the effective-data total is set as a number 100%. And carry out the averaging operator of the load value of 85 - 95% number data (effective cutting load data) of the high order, and let it be a cutting load value at that time. In addition, numeric values, such as M %, S %, and P etc. %, are C parameter 6C at the parameter section 6. It carries out, and sets up or memorizes.
[0036] Next, processing of the supervisory equipment of a cutting load is explained along with the flow chart of drawing 2 and drawing 3 .
[0037] By starting of processing, first, instruction cutting judges whether it is real cutting, and, in instruction cutting, in real cutting of the processing after step 100, performs processing after step 110 (step 100). And instruction cutting for calculating the reference value of a cutting load is started (step 101), and cutting load detection data (cutting load data) are memorized in the cutting data storage section 7 (step 102). Subsequently, it judges whether all instruction cutting was completed (step 103), if it has not ended, the cutting load data storage of step 102 is repeated, and it sets from the cutting load data memorized when having ended to the cutting value operation part 7, and it is C parameter 6C. Inner predetermined % (M %) extracts effective cutting value data (step 104).
[0038] Similarly it sets to the cutting value operation part 7, and is C parameter 6C. By inner predetermined % (S %, P %), a part for unstable data is removed out of said effective cutting load

data (step 105), and the averaging operator of the cutting load value of the parameter range is carried out (step 106). This averaged cutting load value is memorized as a reference value in the cutting reference-value storage section 10 (step 107).
[0039] Subsequently, O parameter 6O of a cutting load reference value and the parameter section 6 calculated in the cutting value operation part 7 in the outlying-observation operation part 9 It calculates with an inner multiplier and the result is memorized in the cutting outlying-observation storage section 12 as an abnormality decision value in cutting (step 108). Moreover, W parameter 6W of the cutting load reference value calculated by the cutting operation part 7 in the wear operation part 8, and the parameter section 6 By the multiplier, it is [0040]. Wear decision value = cutting load reference-value xW parameter value [0041] ****** is performed. The result is memorized in the wear value storage section 11 as a wear decision value (step 109).
[0042] In drawing 3 , if real cutting is started (step 110), the abnormality decision value in cutting and a wear decision value will be read from the wear value storage section 11 (step 111), and, subsequently a cutting load reference value will be read from the criteria load value storage section 10 (step 112).
[0043] Next, it is A parameter 6A about a cutting load upper limit and a lower limit. It calculates and sets up with the cutting load reference value memorized by a multiplier and said reference-value storage section 10 (step 113).
[0044] Subsequently, it sets to comparators 17 and 18 and the real cutting load data of the real time under real cutting, and a cutting load upper limit and a lower limit are a degree type [0045]. Load upper-limit > load lower limit [0046] It judges whether ****** is formed or not (step 114), and when materialized, processing after step 116 is performed.
[0047] On the other hand, if not materialized, processing which will output the over-writing downward signal of the feed rate of a feed shaft servo motor to control-device M-C if it is a cutting load upper-limit < real cutting load data is performed, and if it is a cutting load upper-limit > real cutting load data, output processing of an over-writing rise signal will be performed, for example (step 115).
[0048] The control device MC into which the over-writing rise signal or the over-writing downward signal was inputted controls the delivery override function of a feed shaft drive motor according to override rise / downward signal.
[0049] Next, in a comparator 16, it judges whether it is an abnormality decision value in cutting < real cutting load data (step 116), and if it is a cutting decision value < real cutting load data, a malfunction detection signal will be outputted, an alarm will be displayed and processing of this invention will be ended.
[0050] If a malfunction detection signal is inputted into control unit M-C, control unit M-C will suspend each drive motor of a feed shaft and a main shaft in order to interrupt cutting.
[0051] On the other hand, if it is not an abnormality decision value in cutting < real cutting load data, a real cutting load data will be memorized in the cutting data storage section 5 (step 118), and it will judge whether it is processing termination (step 119). In this decision, if it is not processing termination, the processing from step 114 will be repeated.
[0052] If it is processing termination, the cutting value operation part 7 will calculate the real cutting load value at that time by the real cutting load data of the cutting data storage section 5, and the multiplier in C parameter of the parameter section 6 (step 120). And the wear decision value from the wear value storage section 11 is compared with a real cutting load value in a comparator circuit 15. Namely, judge whether a wear decision value > real cutting load value is satisfied (step 121), and if this calculated value is a wear decision value > real cutting load value as a result of decision Processing of this invention is ended, if it is not a wear decision value > real cutting load value, a wear detecting signal will be inputted into control unit M-C, that tool will be registered as a wear tool in the tool control of control unit M-C (step 122), and processing of this invention will be ended. In addition, when a tool is registered as a wear tool and the reserve tool is registered beforehand, a reserve tool will be used from the next processing.
[0053] The example of the data of the cutting load supervisory equipment when cutting with the

6 inch milling cutter of an eight-sheet cutting edge to drawing 5 and drawing 6 is shown. As shown in drawing, the same operation data (reference value) as the conventional maximum method are obtained also for this invention, and responsibility is good.
[0054] In the wear judging of a tool, by the conventional method, when wearing early load 18.5A out, it increases to 19.9A and the load is increasing 7.8%. By the method of this invention, when wearing out early load value 18.4A, it is detected as increasing to 21.9A and the load increasing 19%. Thus, since change of a load took greatly, while exact wear detection was completed, it came to be able to carry out the wear judging also of the tool which was not able to be judged by the conventional method.
[0055] In addition, what is necessary is to be the method which detects the torque of each driving shaft, and to just be outputted in proportion to a cutting load in short, although the method detected with the current value of a drive motor explains the cutting load in this example.
[0056]
[Effect of the Invention] Since data processing which memorized the cutting load data and has held the whole cutting from that stored data at the time of cutting termination can be performed above according to this invention, real cutting and the congruous cutting load reference values which are influenced by neither a noise nor the disturbance factor are stabilized, and are calculated. Moreover, according to this invention, since a reliable cutting load reference value is acquired easily, anyone can perform the high monitor of sensibility with sufficient responsibility. Furthermore, according to this invention, since monitor data are unified into a cutting load reference value, it becomes a system intelligible for an operator.

[Translation done.]

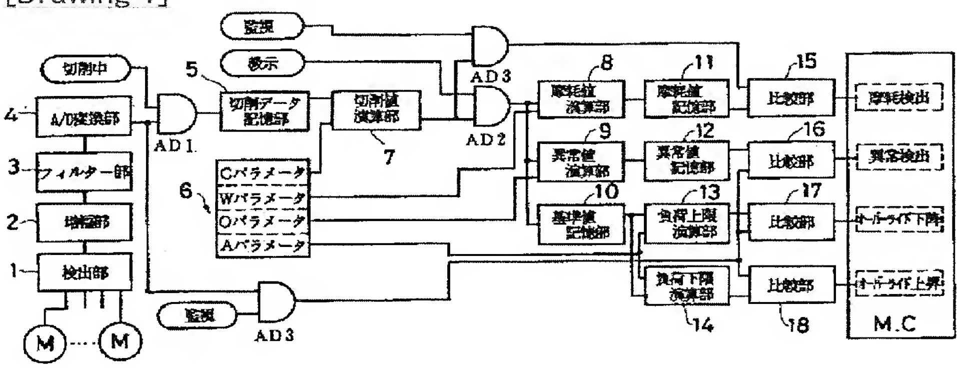
DESCRIPTION OF DRAWINGS

[Brief Description of the Drawings]
[Drawing 1] It is the block diagram of the cutting load supervisory equipment which carries out this invention.
[Drawing 2] It is the flow chart of instruction cutting processing of this invention.
[Drawing 3] It is the flow chart of monitor processing of the cutting load at the time of real cutting of this invention.
[Drawing 4] It is the explanatory view of the example of a cutting pattern of this invention.
[Drawing 5] It is an operation data Fig. by the new tool of this invention.
[Drawing 6] It is an operation data Fig. by the wear tool of this invention.
[Description of Notations]
M-C Control unit
1 Detecting Element
2 Amplifier
3 Filter Section
4 A/D-Conversion Section
5 Cutting Data Storage Section
6 Various Parameter Sections
7 Cutting Value Operation Part
8 Wear Value Operation Part
9 Outlying-Observation Operation Part
10 Reference-Value Storage Section
11 Wear Value Storage Section
12 Outlying-Observation Storage Section
13 Load Upper Limit Operation Part
14 Load Minimum Operation Part
15-18 Comparator

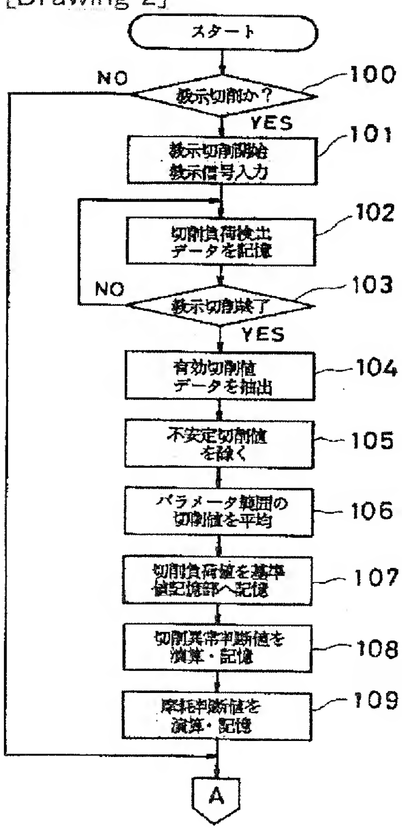
[Translation done.]

DRAWINGS

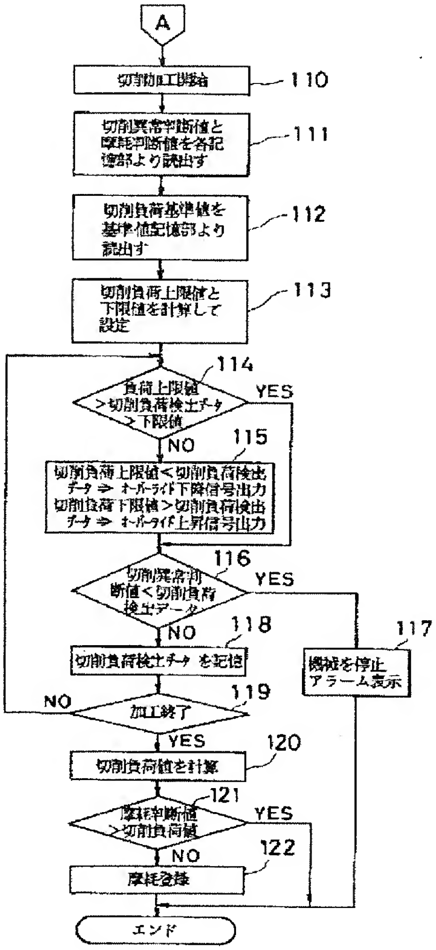
[Drawing 1]



[Drawing 2]



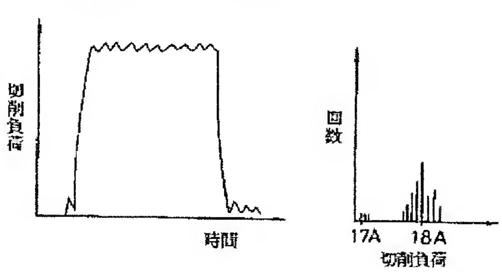
[Drawing 3]



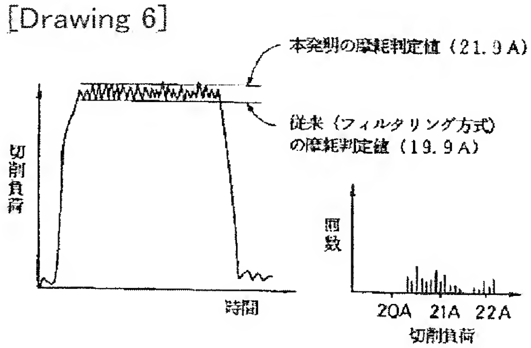
[Drawing 5]

従来（最大値方式） 18.5 A

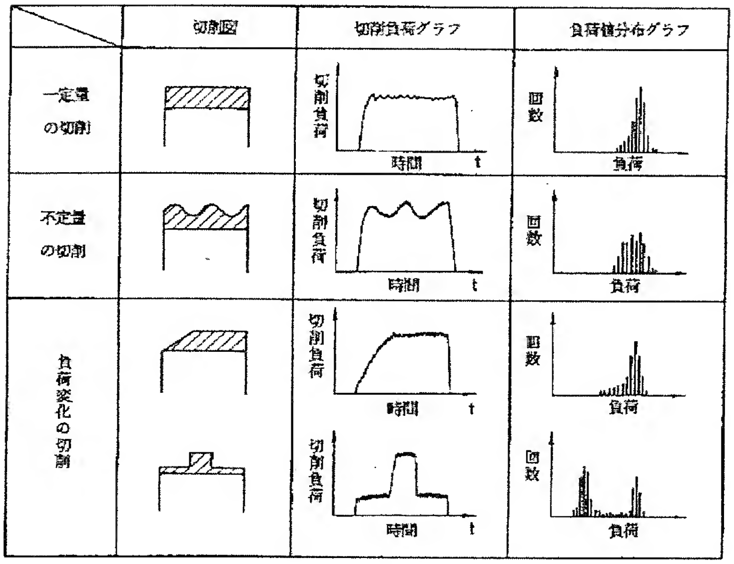
本発明 18.4 A



[Drawing 6]



[Drawing 4]



[Translation done.]

(19)日本国特許庁（ＪＰ）　(12) **公開特許公報**（Ａ）　(11)特許出願公開番号

特開平4－269153

(43)公開日　平成４年(1992) ９月25日

(51)Int.Cl.⁵	識別記号	庁内整理番号	ＦＩ	技術表示箇所
Ｂ２３Ｑ　17/09	Ｈ	7632－3Ｃ		

審査請求　未請求　請求項の数３(全　７　頁)

(21)出願番号　特願平3－28727

(22)出願日　平成３年(1991) ２月22日

(71)出願人　000233321
日立精機株式会社
千葉県我孫子市我孫子１番地

(72)発明者　寺嶋　厚
千葉県我孫子市我孫子１番地　日立精機株式会社内

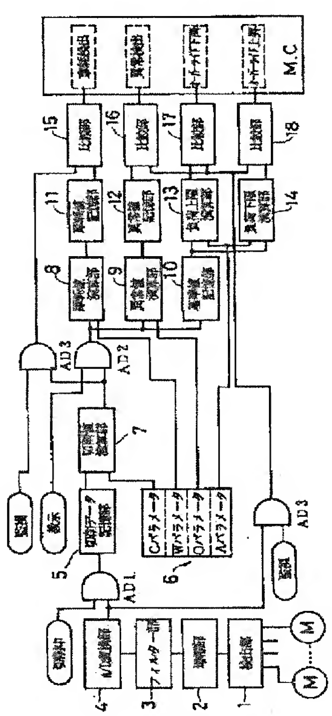
(74)代理人　弁理士　磯野　道造

(54)【発明の名称】　データ抽出平均法による切削負荷監視方法

(57)【要約】　　(修正有)

【目的】切削加工において、信頼性高く、応答性も良好で、オペレータの識別やデータの変更容易な、切削負荷監視装置を提供する。

【構成】監視する基準値を得るために、実際の加工に先立って教示切削を行う。その時、主軸や送り軸から検出する各工程の切削負荷検出データを記憶する。各工程の切削が終わった時に、その加工工具の実切削に則した負荷値を演算し、その値を工具の切削負荷基準値として記憶する。この基準値から切削異常判断値と摩耗判断値を演算して記憶すると共に、切削負荷状態のグラフィック表示と切削負荷基準値、切削異常判断値と摩耗判断値を図表示する。



【特許請求の範囲】

【請求項１】　工作機械において、教示切削中の切削負荷を、主軸や送り軸の駆動系から検出し、検出した切削負荷データを記憶部に記憶し、切削終了後に、この記憶した切削負荷データから所定の範囲内の有効切削負荷データを抽出し、この抽出した有効切削負荷データを平均した切削負荷値を演算し、この切削負荷値を切削負荷の基準値として演算された切削異常判断値と、実切削中の主軸や送り軸の駆動系から検出した切削負荷データとを比較し、この切削負荷データが異常か否かを判断し、異常の場合には切削異常の信号を出力することを特徴とするデータ抽出平均法による切削負荷監視方法。

【請求項２】　工作機械において、教示切削中の切削負荷を、主軸や送り軸の駆動系から検出し、検出した切削負荷データを記憶部に記憶し、切削終了後に、この記憶した切削負荷データから所定の範囲内の有効切削負荷データを抽出し、この抽出した有効切削負荷データを平均した切削負荷値を演算し、この切削負荷値を切削負荷の基準値として演算された磨耗判断値と、切削終了後に実切削中の主軸や送り軸の駆動系から検出した切削負荷データから所定の範囲内の有効切削負荷データを抽出し、この抽出した有効切削負荷データの平均値を演算した実切削時の切削負荷値とを比較し、この切削負荷値データが異常か否かを判断し、異常の場合には工具摩耗の信号を出力することを特徴とするデータ抽出平均法による切削負荷監視方法。

【請求項３】　請求項１および請求項２において、前記切削負荷データから前記切削負荷値を求める演算は、切削量の変化による影響を除去するために、切削負荷データの負荷値の大きい順に上位から所定数の負荷値を抽出し、この抽出した負荷値からノイズや外乱の影響を除去するために、負荷値の大きい順に上位の所定数の負荷値を除去し、この除去後の負荷値から一定の負荷基準値を得るために、上位の所定数の負荷値を抽出し、この抽出した負荷値を平均して切削負荷値を求める方法であるデータ抽出平均法による切削負荷監視方法。

【発明の詳細な説明】

【０００１】

【産業上の利用分野】本発明は、工作機械の加工時における切削状態を監視する方法に関する。

【０００２】

【従来例】工作機械の切削状態を監視して効率的な運転を行う方法として、主軸モータや送り軸サーボモータの切削負荷を監視する方法がある。

【０００３】主軸や送り軸の駆動モータから切削中の切削負荷として電流値を検出して、切削異常を検出する場合、一度、教示切削を行い、その時の高周波ノイズ成分を除いた切削負荷検出データから、（ａ）切削負荷検出データの最大値を基準値として設定する、あるいは（ｂ）切削負荷検出データの連続Ｎ回平均値を算出し、その平均値のうちの最大値を基準値として求め、この基準値を基にした制限設定値と実切削データを比較して監視を行っていた。

【０００４】また、工具摩耗は、工具の摩耗が切削負荷の直流成分上昇と負荷変動の上昇として検出される。そのため、（ｃ）検出データをフィルタリングした直流成分の変化を比較して検出する、あるいは（ｄ）検出データを比較し、比較条件に時間要素を入れて直流成分の上昇を検出する等の方法で検出処理が行われている。

【０００５】

【発明が解決しようとする課題】しかし、切削負荷検出データの最大値を基準値とする方法、あるいは切削負荷検出データの連続Ｎ回平均値の最大値を基準値とする方法は切削負荷検出データの最大値を基にしている為、以下に示す問題点が存在する。

【０００６】すなわち、切削負荷の検出データは切削していない状態でも、駆動機構の伝達損失や駆動系の応答特性により変動が生じることがある。特に、重切削になる程、変動も大きくなる。また、切削条件を変えずに切削しても、フライスやエンドミル切削では、断続切削となるため切削負荷は変動してしまう。特に、ドリル等は切粉がからみ切削負荷が変動する。そして、連続Ｎ回平均では、切削負荷検出データの変動サイクルが各種切削条件等で変わるため、効果的な平均化回数Ｎを決められない。また、平均化回数Ｎを多くすれば、データは安定するが、検出データへの応答が遅くなるとともに、検出データの変化が低くなってしまう。さらに、平均的な切削負荷値と最大値の間には差があり、かつデータとして変動の大きい最大値を基準値にする方法は基準値のデータ信頼度が低くなるため、当然監視感度も悪くなる。また、平均化回数Ｎを大きくすれば、データは安定するが応答が遅くなる為、工具折損等の突発的な切削負荷値の上昇などの変化を検出できない恐れがあるという問題点を生じていた。

【０００７】このように切削負荷の監視方法においては、監視を行う判定基準値の取り方と精度が最重要な課題の一つとなる。

【０００８】また、前記した摩耗検出処理では、以下に示す問題点が存在する。

【０００９】すなわち、フィルタリングした直流成分データで比較するので、前記した切削負荷の監視の処理系とは別のデータ処理系が必要でありデータ処理系が２重になり、コスト高になる。切削異常と摩耗用の２種類のデータ設定が必要となり、オペレータにとって煩雑で分かりにくい。フィルタリングするので、切削データが低くなり検出精度が下がる。また、摩耗した工具の方がデータ変動幅が大きくなり、フィルタリングの影響が大きくなるという問題点も生じていた。

【００１０】この発明はかかる課題に鑑みて創案されたものであり、教示切削の切削負荷検出データを記憶する

ことで、切削終了時に、その記憶した切削負荷検出データから切削全体の負荷状態を判断して、実切削に即した切削負荷値を演算し、この値を切削負荷監視の基準値としたことで、分かりやすく信頼性も高く、しかも、応答性も良い切削負荷監視が行える切削負荷の監視方法を提供することを目的とする。

【0011】

【課題を解決するための手段】前記課題を解決するために、この発明は、工作機械において、教示切削中の切削負荷を、主軸や送り軸の駆動系から検出し、検出した切削負荷データを記憶部に記憶し、切削終了後に、この記憶した切削負荷データから所定の範囲内の有効切削負荷データを抽出し、この抽出した有効切削負荷データを平均した切削負荷値を演算し、この切削負荷値を切削負荷の基準値として演算された切削異常判断値と、実切削中の主軸や送り軸の駆動系から検出した切削負荷データとを比較し、この切削負荷データが異常か否かを判断し、異常の場合には切削異常の信号を出力することを特徴とする。

【0012】また、この発明は工作機械において、教示切削中の切削負荷を、主軸や送り軸の駆動系から検出し、検出した切削負荷データを記憶部に記憶し、切削終了後に、この記憶した切削負荷データから所定の範囲内の有効切削負荷データを抽出し、この抽出した有効切削負荷データを平均した切削負荷値を演算し、この切削負荷値を切削負荷の基準値として演算された摩耗判断値と、切削終了後に実切削中の主軸や送り軸の駆動系から検出した切削負荷データから所定の範囲内の有効切削負荷データを抽出し、この抽出した有効切削負荷データの平均値を演算した実切削時の切削負荷値とを比較し、この切削負荷値データが異常か否かを判断し、異常の場合には工具摩耗の信号を出力することを特徴とする。

【0013】さらに、この発明は前記切削負荷データから前記切削負荷値を求める演算は、切削量の変化による影響を除去するために、切削負荷データの負荷値の大きい順に上位から所定数の負荷値を抽出し、この抽出した負荷値からノイズや外乱の影響を除去するために、負荷値の大きい順に上位の所定数の負荷値を除去し、この除去後の負荷値から一定の負荷基準値を得るために、上位の所定数の負荷値を抽出し、この抽出した負荷値を平均して切削負荷値を求めることを特徴とする。

【0014】

【作用】切削加工時における負荷状態を表示する表示装置を具備した切削負荷の監視装置において、監視する基準値を得るために、実際の加工に先立って教示切削を行う。その時、主軸や送り軸の駆動系から検出する各工程の切削負荷検出データを記憶し、各工程の切削が終わった時に、その加工工具の実切削に即した切削負荷値を演算し、その値を工具の切削負荷の基準値として記憶する。この基準値から切削異常判断値と摩耗判断値とを演算して記憶すると共に、切削時の切削負荷状態のグラフィック表示と演算による切削負荷の基準値、切削異常判断値と摩耗判断値を図表示するからオペレータは識別が容易にでき、データ変更も容易に行うことができる。

【0015】また、この時、切削異常の監視は、実切削データを切削異常判断値とリアルタイムで比較して監視を行うことができ、工具摩耗は、切削終了時に毎回切削負荷値を演算し、摩耗判断値と比較して監視を行うことができる。さらに、切削負荷の基準値より導き出される切削負荷範囲内に実切削負荷が入るように、切削送り速度を適時変更する適応制御も行う。

【0016】

【実施例】以下、この発明の一実施例を図面に基づいて詳しく説明する。

【0017】図1はこの発明を実施する切削負荷監視装置のブロック図である。

【0018】図1に示すM・Cは工作機械の制御装置（NC装置、プログラマブルコントローラ）であり、摩耗検出処理手段、異常検出処理手段、送りオーバーライト下降手段、送りオーバーライト上昇手段等を有している。

【0019】1は検出部であり、主軸駆動モータや送り軸駆動モータから切削負荷としてモータ負荷（電流値）を検出する。2は検出部1で検出した電流値を増幅する増幅部、3は電気的ノイズを除去するフィルター部、4はアナログ信号をデジタル信号へ変換するA／D変換部である。なお、具体的な制御判断処理はこのデジタルデータで行う。

【0020】AD1はアンドゲートであり、切削中の信号が入力されると、切削データ記憶部5にデータを出力する。切削データ記憶部5は、切削中の切削負荷検出データを記憶する。6は各演算部で使用する数値を記憶している各種パラメータ部である。7は切削値演算部であり、切削が完了すると、処理が起動され、切削データ記憶部5で記憶された切削負荷検出データと各種パラメータ部6のCパラメータ6_Cに設定されている加工工具の演算用パラメータとにより、その時の切削負荷値の演算を行い、基準負荷値記憶部10は、演算した切削負荷値を基準値として記憶する。8は摩耗値演算部であり、摩耗値演算部8では前記切削負荷値とパラメータ部6のWパラメータ6_Wに設定されている数値とにより演算を行い、その結果を、摩耗判断値として摩耗値記憶部11に記憶する。9は異常値演算部であり、異常値演算部9では前記切削負荷値とパラメータ部6のOパラメータ6_Oに設定されている数値とにより演算を行い、その結果を、切削異常判断値として切削異常値記憶部12に記憶する。Wパラメータ6_W、Oパラメータ6_Oに記憶されている数値は工具毎または工具種別毎に設定が可能となっている。

【0021】AD2はアンドゲートであり、切削値演算

部７において切削終了後、切削負荷値を演算し、かつ、教示切削をしているとの教示信号が入力されているときのみ切削負荷値を摩耗演算部８、異常値演算部９、基準値記憶部１０に出力する。

【００２２】ＡＤ３はアンドゲートであり、教示切削でなく実切削を行って切削負荷の監視を行っているとき、すなわち監視信号が入力されているときに、切削中の切削負荷検知データをリアルタイムで比較部１６、比較部１７、比較部１８に出力する。また、切削終了後に切削値演算部７で演算された切削負荷値を比較部１５に出力する。

【００２３】比較部１５では、摩耗値記憶部１１に記憶されている摩耗判断値と、今回、切削した時の切削負荷値とを比較し、摩耗判断値＜切削負荷値となった時に、制御装置Ｍ・Ｃに工具摩耗検出信号を出力する。

【００２４】比較部１６では、異常値記憶部１２に記憶されている切削異常判断値と、切削中のリアルタイムの切削負荷検出データとを比較し、切削異常判断値＜切削負荷検出データとなった時に、制御装置Ｍ・Ｃに工具異常検出信号を出力する。

【００２５】１３は切削負荷上限演算部であり、基準値記憶部１０に記憶された切削負荷基準値とＡパラメータ6_Aに設定された数値とにより切削している工具で許容する切削負荷の上限値を演算し、その結果を比較部１７に出力する。

【００２６】１４は切削負荷下限演算部であり、同様に、切削している工具で許容する切削負荷の下限値を演算し、その結果を比較部１８に出力する。このＡパラメータ6_Aの数値は工具毎に任意に設定することが可能であり、例えば、

【００２７】切削負荷上限値＝１２０％×切削負荷基準値、

【００２８】切削負荷下限値＝　８０％×切削負荷基準値

【００２９】とすれば、「１２０」、「８０」の数値が設定されている。

【００３０】比較部１７，１８では、各々演算された切削負荷上限値、切削負荷下限値と切削中のリアルタイムの切削負荷検出データとを比較し、切削負荷検出データが切削負荷上限値以上のとき、または切削負荷下限値以下の時に制御装置Ｍ・Ｃにオーバーライド下降信号またはオーバーライド上昇信号を出力する。

【００３１】次に、切削値演算部７において行われる切削負荷値の演算処理方法について説明を行う。

【００３２】前記切削データ記憶部５に記憶された切削負荷検出データより突発データによる影響と、図４の切削パターン例に示す切削量の変化による影響を除く為に、全データを負荷値の大きい順に分類し、データ総数を１００％数にした内の上位１０％数の負荷値を読み、その負荷値のＭ％以上の切削負荷検出データを有効データとする。なお、Ｍ％は通常６０％とするが、工具の種別毎または工具毎に任意に設定が行えるように構成する。

【００３３】ついで、演算除外範囲の指定について説明する。最大負荷値側のデータは、ノイズや外乱等の影響を受け、不安定なデータとなる。そこで、この影響を無くす為、有効データ総数を１００％数にした最大負荷値側のＳ％数のデータを演算から除く。なお、Ｓ％は通常５％とするが、工具の種別毎または工具毎に任意に設定が行えるよう構成する。

【００３４】どの様な切削でも切削負荷は変動するが、切削条件を越える切削は行われないので、有効切削データの大きい方のデータに着目すれば、負荷変動に惑わされることなく、一定の負荷基準値を得ることができる。そこで、この演算範囲をＰ％で指定する。なお、Ｐ％は通常１０％とするが、工具の種別毎または工具毎に任意に設定が行えるよう構成する。

【００３５】通常は記憶した切削負荷検出データから有効切削値データを選び、その有効データ総数を１００％数に設定する。そして、その上位８５～９５％数データの負荷値を平均し、それをその時の切削負荷値とする。なお、Ｍ％、Ｓ％、Ｐ％などの数値はパラメータ部６でＣパラメータ6_Cとして設定、あるいは記憶されている。

【００３６】次に、図２および図３のフローチャートに沿って切削負荷の監視装置の処理を説明する。

【００３７】処理の起動により、まず、教示切削が実切削かを判断し、教示切削の場合にはステップ１００以降の処理を、実切削の場合にはステップ１１０以降の処理を行う（ステップ１００）。そして、基準値を求めるための教示切削が開始され（ステップ１０１）、切削負荷検出データを切削データ記憶部５に記憶する（ステップ１０２）。ついで、教示切削が全て終了したかどうかの判断を行い（ステップ１０３）、終了していなければ、ステップ１０２の切削負荷検出データの記憶を繰り返し、終了していれば、記憶した切削負荷検出データから切削値演算部７において、Ｃパラメータ6_C内の数値（Ｍ％）によって有効切削値データを抽出する（ステップ１０４）。

【００３８】同じく切削値演算部７において、Ｃパラメータ6_C内の数値（Ｓ％、Ｐ％）によって、前記有効切削値データの中から不安定切削値を取り除き（ステップ１０５）、パラメータ範囲の切削負荷値を平均する（ステップ１０６）。この平均された切削負荷値を切削基準値記憶部１０に基準値として記憶する（ステップ１０７）。

【００３９】ついで、異常値演算部９では切削値演算部７において、演算された切削負荷値とパラメータ部６のＯパラメータ6_O内の数値によって演算を行い、その結果を、切削異常判断値として切削異常値記憶部１２に記

憶する（ステップ１０８）。又、摩耗値演算部８では切削値演算部７で演算した切削負荷値とパラメータ部６のWパラメータ6_Wの数値とにより、

【００４０】

摩耗判断値＝切削負荷値×Wパラメータ値

【００４１】の演算を行う。その結果を、摩耗判断値として摩耗値記憶部１１に記憶する（ステップ１０９）。

【００４２】図３において、実切削加工を開始すると（ステップ１１０）、切削異常判断値と摩耗判断値を摩耗値記憶部１１より読み出し（ステップ１１１）、ついで、切削負荷基準値を基準値記憶部１０より読み出す（ステップ１１２）。

【００４３】次に、切削負荷上限値と下限値をAパラメータ6_Aの数値と前記基準値記憶部１０に記憶される切削負荷基準値とで計算して設定する（ステップ１１３）。

【００４４】ついで、比較部１７，１８において、切削中のリアルタイムの切削負荷検出データと切削負荷上限値、下限値とが、次式

【００４５】負荷上限値＞負荷下限値

【００４６】の関係を成立させているかどうか判断し（ステップ１１４）、成立している場合には、ステップ１１６以降の処理を行う。

【００４７】一方、成立しなければ、例えば、切削負荷上限値＜切削負荷検出データであれば、送り軸サーボモータの送り速度のオーバーライト下降信号を制御装置M・Cに出力する処理を行い、切削負荷上限値＞切削負荷検出データであれば、オーバーライト上昇信号の出力処理を行う（ステップ１１５）。

【００４８】オーバーライト上昇信号またはオーバーライト下降信号が入力された制御装置M・Cはオーバーライド上昇／下降信号に従って送り軸駆動モータの送りオーバーライド機能を制御する。

【００４９】次に、比較部１６において切削異常判断値＜切削負荷検出データかどうか判断し（ステップ１１６）、切削異常判断値＜切削負荷検出データであれば、異常検出信号を出力し、アラームを表示してこの発明の処理を終了する。

【００５０】異常検出信号が制御装置M・Cに入力されると、制御装置M・Cは切削加工を中断するため、送り軸、主軸の各駆動モータを停止する。

【００５１】一方、切削異常判断値＜切削負荷検出データでなければ、切削データ記憶部５に切削負荷検出データを記憶し（ステップ１１８）、加工終了かどうか判断する（ステップ１１９）。この判断において、加工終了でなければ、ステップ１１４からの処理を繰り返す。

【００５２】加工終了であれば、切削値演算部７は切削データ記憶部５の切削負荷検出データとパラメータ部６のCパラメータ内の数値とでその時の切削負荷値を計算する（ステップ１２０）。そして、比較回路１５で摩耗値記憶部１１からの摩耗判断値と切削負荷値とを比較する。すなわち、この計算値が、摩耗判断値＞切削負荷値を満足するかどうか判断し（ステップ１２１）、判断の結果、摩耗判断値＞切削負荷値であれば、この発明の処理を終了し、摩耗判断値＞切削負荷値でなければ、制御装置M・Cに摩耗検出信号を入力し、制御装置M・Cの工具管理において、その工具を摩耗工具として登録し（ステップ１２２）、この発明の処理を終了する。なお、工具が摩耗工具として登録され、予備工具があらかじめ登録してある場合には、次の加工からは予備工具を使用することになる。

【００５３】図５及び図６に８枚刃の６インチフライスで切削したときの切削負荷監視装置のデータの例を示す。図に示すように、従来の最大値方式と同様の演算データ（基準値）がこの発明でも得られた。また、この時、応答性が良いという結果が得られた。

【００５４】工具の摩耗判定において従来の方式では初期の負荷１８．５Aが摩耗することにより１９．９Aに増加し、負荷が７．８％増加している。この発明の方式では、初期の負荷値１８．４Aが摩耗することにより２１．９Aに増加し、負荷が１９％増加していると検出される。このように、負荷の変化が大きくとれるため、正確な摩耗検出ができると共に、従来方式では判断出来なかった工具も摩耗判定できるようになった。

【００５５】なお、この実施例では切削負荷を駆動モータの電流値で検出する方式で説明しているが、各駆動軸のトルクを検出する方式であってもよく、要するに切削負荷に比例して出力されるものであればよい。

【００５６】

【発明の効果】以上この発明によれば、切削負荷のデータを記憶して切削終了時に、その記憶データから切削全体を掴んだ演算処理が行える為、ノイズや外乱要因に影響されない、実切削と一致した切削基準値が安定して求められる。また、この発明によれば、信頼性のある切削基準値が誰でも容易に得られるために、応答性が良く感度の高い監視を行うことができる。更に、この発明によれば、監視データが基準値に統一される為に、オペレータに分かりやすいシステムになる。

【図面の簡単な説明】

【図１】この発明を実施する切削負荷監視装置のブロック図である。

【図２】この発明の教示切削処理のフローチャートである。

【図３】この発明の実切削時の切削負荷の監視処理のフローチャートである。

【図４】この発明の切削パターン例の説明図である。

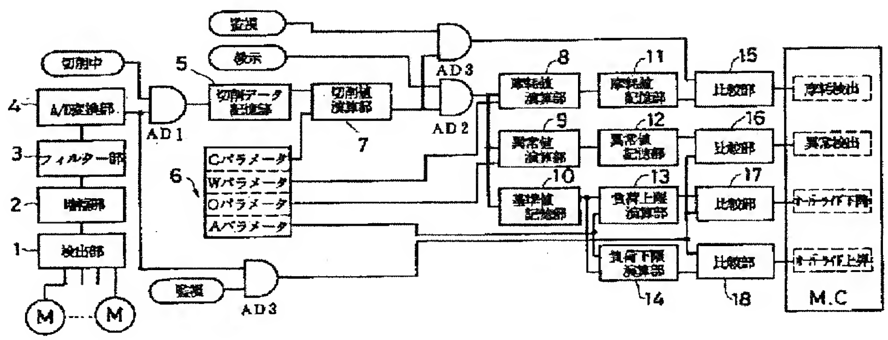
【図５】この発明の新工具による実施データ図である。

【図６】この発明の摩耗工具による実施データ図である。

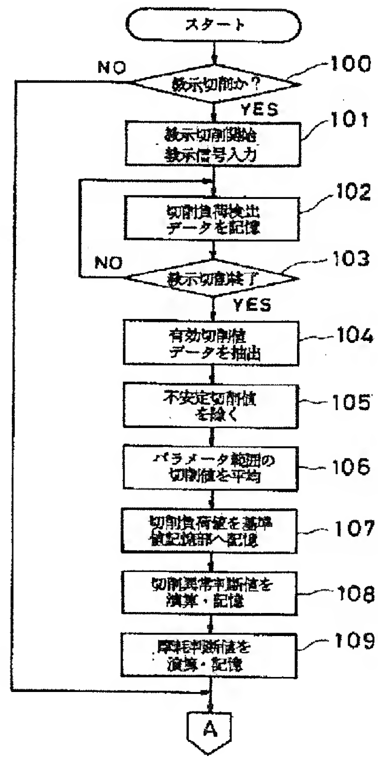
【符号の説明】

M・C　制御装置
1　検出部
2　増幅部
3　フィルター部
4　A／D変換部
5　切削データ記憶部
6　各種パラメータ部
7　切削値演算部
8　摩耗値演算部
9　異常値演算部
10　基準値記憶部
11　摩耗値記憶部
12　異常値記憶部
13　負荷上限演算部
14　負荷下限演算部
15～18　比較部

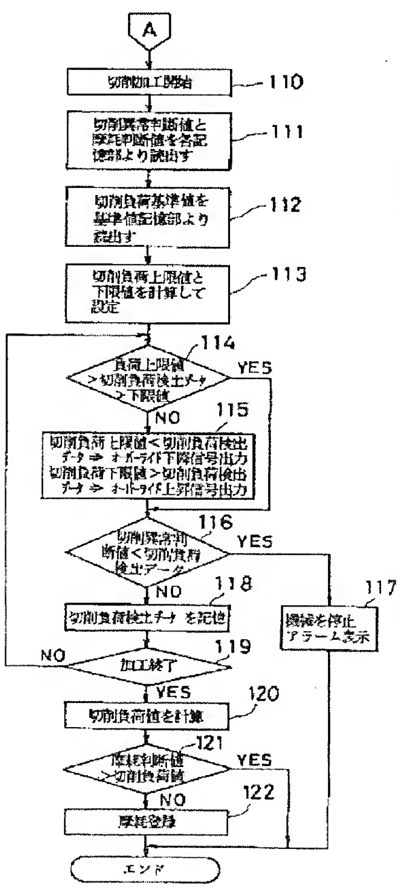
【図1】



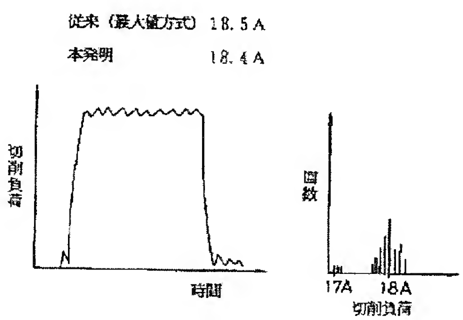
【図2】



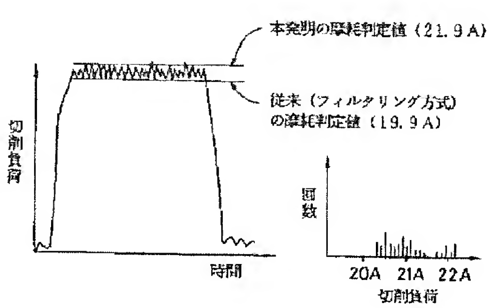
【図3】



【図5】



【図6】



【図4】